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Studies on fly ash and animals

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ABSTRACT

Fly ash is a powdery material produced as by-product during the coal based power generation process. It is a mixture of fine, spherical particles size ranging between 0-100 microns. Fly ash contains heavy metals, trace elements with SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO in its basic composition and has property of deposition as sediments. The study of animals in relation to fly ash is not done, as much as with other pollutants very few workers are concerned with this study. Like N.L. Rose and his coworkers worked on soil and fly ash deposition. Bioaccumulation of fly ash constituents in different texas and impact of fly ash on animal population were reported by Rufus K. Guthrie, Donald S. Cherry (1979) and David F. Spencer (1983), G Brieger et al. (1992) in benthic macro invertebrate and in some plants & animals grazing on them at fly ash dumping area. K. Szymczykiewicz reported lung tissue damage in mice (1983). Miller with his coworkers studied fly ash exposure and mice behavior (1986) similarly In 2012 Bryan studied the behavior of birds to nesting in fly ash basin. In 2004, John H. Roe with his coworkers studied the hatching, growth pattern of reptilian eggs and larvae at fly ash contaminated areas. In 2011 Shrivastava et al. studied the effect of fly ash contamination in different doses on growth and behavior on fish Tilapia mossambica. In this paper we have studied and discussed the previous works which is focused on fly ash and its impact on animals, not only on its body but also on vital processes as growth and tolerance against the other environmental conditions. For this study we acquired research papers from libraries, websites, and also personally communicated with related authorities and experts during our survey. This study is important as a connecting link to observe animal population and the workers working directly on fly ash sites, as on ash dumpings or the source stations, where they will come in contact. Thus by this study we will know the amount and type of work being done and the lacuna existing in this type of study. So that our knowledge and research work can be guided in right direction.

Key words: fly ash; fly ash dyke; effluent; bioaccumulation; animals.

Abbreviation: SCP - Speroid Carbonacious particles.

1. INTRODUCTION

Fly ash is one of the coal combustion residue produced during combustion of fossil fuel like coal at coal based thermal power plant. It is a pozzolanic material and said to have more strength than other building materials. This is not a new material as assumed by many but was already known to many ancient cultures and its use was also known very well to them. It was used as building material in

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ancient times as early as 200 B.C. and has been reported in many cultures which were famous for cement production like –Romans and Nabataeans which named it as pozzolana, which was Volcanic ash. 'Colosseum' is the good example of use of volcanic ash in Roman culture which was built in 100 A.D. & still stands. Vitruvius (Marcus Vitruvius Pollio, c. 80-70 B.C. died after c. 15 B.C.), discussed about a powdery material which was formed due to natural causes and showed astonishing properties. This material was found around the Vesuvius Mountain. The ill named active volcano site, till date, and gave more strength to buildings when it was mixed with lime and rubble; understandably, it was ash from the volcano.

According to the amount percentage of the basic constituent, fly ash is divided into two categories as class C and class F (ASMT). Class F fly ash - having F above 20% and Class C fly ash having Ca above 20% (ASMT C 618). Further class F & class C fly ash divided into Low-Fe, High-Fe and Low-Ca, High-Ca category. Class F generate by the combustion of Anthracite and Bituminous type of coal and Class C fly ash generate by combustion of Sub – Bituminous and Lignite coal. Generally fly ash is known as amorphous ferro-alumino mineral which is present in fly ash as amorphous iron aluminum oxide as well as manganese oxide on the surface of fly ash particles and act as sink, adsorbing the trace elements. The pH of aquatic media is responsible for the solubility of these oxides and further for the mobilization of trace element. Indian coal is reported as alkaline in many studies and fly ash reported high pH value rather than bottom ash. In international context India, China, U.S.A, Germany, UK, Australia, Canada and France are the major fly ash producer countries (Table 1). Fly ash was used continuously in many ways but 100 % use of produced fly ash is a major concern for management of thermal power plant and also for government. Continuous researches had been carried out towards utilization and well management of fly ash. On the world map, Denmark utilized about 100% of total produced fly ash and West Germany and France - 85%, United Kingdom-50%, China-45% respectively but in India utilization percentage is only 38% of total fly ash production. In Chhattisgarh (India) near about 2.34 MT fly ash produced in Korba district, which contributes about 66% of total fly ash production of this state. Due to low cost amiability and good physical characteristics for soil improvement, fly ash inters in our food chain through the crops which is finally reached into the animal's body by the prey-predator system.

Table 1 Some physical properties of fly-ash

S. No.	Parameters	properties
1	Colour	Gray, Brown
2	Shape	Spherical
3	Particle size	1-100 micron
4	Specific gravity	1.90-2.55
5	Plasticity	Non plastic
6	Maximum dry density (gm/cc)	0.90-1.60
7	Optimum moisture content (%)	38.0-18.0
8	Permeability(CM/SEC)	10^{5}-10^{3}

Statement of the problem

Fly ash being a totally inorganic material, It is not a favorite material for study for biologists. Still some scientists have worked with the relation between fly ash and animals. Thus to know about these study we went through a lot of published papers (national and international), in books and journals, and also communicated with many universities.

Scope of study

This study is done to know about the researches already done with fly ash and animals, so that advancement can be brought in the subject and after finding the lacuna in already done works we can proceed to new and untouched aspects of study of fly ash in relation to animal world.

Limitations of the study

The study undertaken is limited to 33 years, i.e. 1979 – 2012. We depended on the libraries and websites for literature collections. No patents are included in our study.

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2. DATA COLLECTION

To know the study done on the inter relation between fly ash and animals we visited libraries and searched research papers with the help of internet and websites. Field study was done by survey and we also communicated with experts. We also visited fly ash dumping sites and communicate with workers and villagers to know how they come to contact to fly ash exposure during their working hour and how many animals they were seen at ash dumping area.

3. DISCUSSION

3.1. Composition of fly ash

Chemically fly ash is composed of SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, and TiO2 in different compositions. Fly ash also contains As, Cd, Ca, Cr, Co, Cu, Pb, Mn, Hg, Ni, F, Zn, Al, B, Ba, Be, Mo and some trace metals along with the basic elements. Fly ash particles are fine particles, their size ranged between- 0 to 100 microns. Fly ash particles were reported as SCP (spheroid carbonaceous particles) in a shallow lake at Denmark by Bent Vad Odgaard in 1993. According to Bent, Fly ash particles are fine particles and spheroid in shape and formed after the combustion fossil fuels which were rich in carbon content. all constituents including trace element formed spherical shaped particle at high temperature. According to Wadge A. et al particle size of fly ash also depends on the concentration of constituting trace elements. To determine the surface chemistry of particles produced from fossil fuel, N.L. Rose and his coworkers used Energy Dispersive Spectroscopy in 1994, and published a note on extraction procedure for fly ash particles from lake sediments. In 2006 Snigdha Sushil and Vidya S. Batra studied the heavy metal concentration in fly ash & bottom ash in India. They recorded the presence of Cr, Mn, Pb, Zn, Cu, Ni, Co in detectable amount and they compared their data from the fly ash composition of other countries. They reported presence of Pb in every sample in significant amount. Some elements of fly ash were showed leaching property at different quantity. According to Praharaj T. et al and Piekos R. some constituent of fly ash are leachable in different quantity which is dependent on the coal type.

3.2. Botanical aspects and soil structure

U.N. Rai et al. (2004) studied the revegetation on the fly ash landfills with Prosopis julifera and the Rizobium inoculation in fly ash landfill. In 2009 S. Sarojini et al reported use of the fly ash – soil bed in different composition in vermiculture and find fly ash –soil combination good for Pheritima growth. Hrishikesh N. Vitekari et al. (2012) reported the use of fly ash as pesticides at yields of many crops in India & reported fly ash as a soil nutritive material.

3.3. Limnological aspects of fly ash

As we know from previous studies, fly ash was dumped in large land areas in slurry form known as fly ash dykes, but at few times dried fly ash is collected from that dyke for further use, in this dyke water is removed from slurry and is collected into a manmade pond which is known as fly ash discharge water pond or fly ash lagoon, in this pond fly ash settles at pond bottom and excess water is disposed off into nearby water body that is a small river. Effect of fly ash discharge water on limnology of the receiving natural water body is studied by some researches. Archana Walia (1995) studied the physiochemical characteristics of river Yamuna. She followed the methods for testing water quality discussed in APHA. In context of coal effluent contamination and reported the negative effect of thermal influents on the physiochemical properties of river water and on planktonic population. Siva kumar (1996) reported contamination of fly ash constituent in ground water source situated nearly to the fly ash dyke. Archana Walia and N.K. Mehra (1997) studied the Indraprastha Thermal power station situated at west side of river Yamuna with having capacity of 225 MW. This thermal power station used near about 4000 bituminous coal daily and produced 1600 tons of fly ash. They tested physio-chemical parameters at three sites. One is fly ash pond, second one was non contaminated area of river, and third one was contaminated area of river and reported slightly high temperature at fly ash pond and at fly ash effluent receiving point of river and reported higher concentration of several elements in Yamuna.

3.4 Biological aspects of fly ash and animals

The study of fly ash in connection to biological aspects started from 1979 when Donald S. Cherry studied the distribution and density of aquatic invertebrates inhabiting in coal ash effluent receiving drainage system the effect of chemicals associated with fly ash. The constituent of fly ash reached to the animal tissue but also accumulates in tissues. Rufus K. Guthrie, Donald S. Cherry (1979) reported the bioaccumulation of 10 elements associated with coal ash in fauna in different trophic levels at fly ash basin. After receiving fly ash contamination not only physiochemical properties were changed of receiving water body although biological structure were affected, as reported in some following studies-

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David F. Spencer et al (1983) reported the effect of fly ash on zooplanktonic community structure in a fly ash treated lake in Indiana. They observed the change in species diversity of Cladocera in lake, in before non treated condition and after the addition of 1.8 X 10^4 kg fly ash with lime at same quantity and concluded that the Cladocera were dominant during September to December before the fly ash treatment. After the fly ash treatment Cladocera were dominant during November to May. Donald S. Cherry, Rufus K. Guthrie (1984) studied the effect of coal ash effluents on chemical parameters of receiving water body and on the population density of benthic macro invertebrate. In 1992, G Brieger et al. reported heavy metal in fly ash and some plants & animals grazing on them at fly ash dumping area. According to N.L. Rose (1994) coal and oil combustion and industrialization affects the lake sediment structure and its composition and they were found a positive relationship between SCP and sulphur deposition in lake. N.L. Rose worked continued with their coworkers and in 1998, as their series research work they found some trace metals were associated with SCP in lake sediments and their tendency of deposition was according to their fuel type consumption, they also used fly ash particles for dating lake sediments. At the same year under the Flame research project J. Fott, J. Vukic & N.L. Rose analyzed SCP concentration in surface sediments samples from manmade lake and natural lake at Czeh Republic and concluded the SCP concentration as stress indicator for human and environmental health. In October 1997 Central region energy resources team reported the presence of some radioactive elements in coal and also in fly ash published in Fact Sheet FS-163-97. All these constituents of fly ash reaches ecosystem by various ways as through dumping, direct exposure, by food chain and web and through the use of fly ash in our daily needs as fertilizer, landfills etc.

Table 2 Typical composition of fly ash (in Wt. %)

		Class F	Class F	Class C	Class C
S.No	**element**	**Low-Fe**	**High-Fe**	**High-Ca**	**Low -Ca**
1	SiO_2	46-57	42-54	25-42	46-49
2	Al_2O_3	18-29	16.5-24	15-21	14-22
3	Fe_2O_3	6-16	16-24	5-10	5-13
4	CaO	1.8-5.5	1.3-3.8	17-32	8-16
5	MgO	0.7-2.1	0.3-1.2	4.12.5	3.2-4.9
6	K_2O	1.9-2.8	2.1-2.7	0.3-1.6	0.6-1.1
7	Na_2O	0.2-1.1	0.2-0.9	0.8-6.0	1.3-4.2
8	SO_3	0.4-2.9	0.5-1.8	0.4-5.0	0.4-2.5
9	TiO_2	1-2	1-1.5	<1	<1

A. Dennis Lemly (1999) studied the effect of Selenium on the Fish. That selenium enters through the irrigation of seleniferous soil for crop production and through the procurement, processing & combustion of fossil fuel in ecosystem. In aquatic organism as in fish Se bioaccumulated in the body of habituating fish in Selenium contaminated water and have been affect through following steps –

- High food chain bioaccumulation
- Steep toxic response curve for fish
- Insidious mode of toxicity

N.L. Rose et al (2001) found that SCP (Spherical carbonaceous fly ash particles) was produced during the combustion of fossil fuel at the very high temperature thus provide the information of element deposition in environment from the fuel. They reported that SCP and SO_4^{2-} + NO^{3-} deposition were more positively correlated than other acid ions .and Deposition of NH^{4+} from fossil fuel combustion were negligible. But at Gossenkollesee they were found positive correlation in-betweens Cl^- deposition and SCP. During 1998-2001 N.L. Rose and his coworkers reported high level of deposition of SCP in soil and lake sediments and concluded that continuous and high deposition of spheroid carbonaceous particle may be a reason for climate change through the increased in soil erosion by many other factors at Europe), Brigden k. & Santillo D. reported some heavy metals in fly ash samples from three coal based power plant at Philippines and focused on Fluoride ion leaching at different pH and temperature conditions in ground water. There are only a few studies done on the fauna and flora which were at the dyke site. Shikha Shrivastava (2006) studied the fauna and flora diversity at fly ash dumping yard as in ash slurry, ash dyke, discharge water pond, reclaimed ash dyke. She was reported presence of some protozoan's like euglena, paramecium, frogs, cranes, grasshopper, beetles, mosquitoes in old ponds and but only euglena, paramecium and mosquitoes reported in drying pond. In moist ash some flies, mosquitoes were found but in dried ash

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only cystic form of organism were found (Table 2). She detects presence of organic matter in fly ash samples collected from the ash dumping area. Along with these fauna some long grasses, a few Parthenium, Calatropis, Solanum nigrum were also reported in fly ash site and similarly in 2007 recorded some insects, reptilians aves and mammals species on reclaimed fly ash dykes of India.

S. Diabate et al. (2002) studied the effect of fly ash contamination on mammalian tissue and reported damage of infected tissue. Jerzy Bilski et al. (2011) studied the accumulation of some crop seeds and their revegetation at coal ash dumping area. Shikha Shrivastava et al. (2011) studied the effect of fly ash contamination in different doses on growth and behavior of Tilapia fish. Like other pollutants fly ash was also affect the physiochemical properties of water body and work as limiting factor for the population of inhabitating organism. In fly ash discharge water along with the heavy pollution being created we have been looking for Zooplanktons. Protozoans, Rotifers, Insects, Amphibians, Fishes etc. were our major aim of concern. There were some studies already done in coal combustion residual area, including fly ash contamination. Rufus K. Guthrie and Donald S. Cherry (1979) reported the presence of bacteria, algae, crayfish, tadpole and fish at coal ash basin drainage system and found higher concentration of Cu, Zn, Cd in different trophic level. K. Szymczykiewicz (1983) observed the effect of bituminous coals ash dust on the lungs tissue of rats and reported tissue damage. Donald S. Cherry et al. (1984) with coworkers studied the effect of coal ash effluents on the water quality and on the density of macro-invertebrates. Miller et al (1986) studied the effect of fly ash dust on mice behavior and reported this fly ash dust as reason of sensory irritation. Hopkins et al (1998) studied the effect of trace metal in toad (Bufo terrestris) inhabitating in fly ash impacted area at United State and compared them with a non polluted reference site. They were reported Ag, Al, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Sr, Tl, U, V,Zn at both fly ash polluted site and in reference non polluted site. All elements were highly concentrated in fly ash polluted site. But only 3 elements - Selenium, Arsenic & Vanadium were reported in significant amount in Bufo terrestris (Table 3).

C L. Rowe et al. (2001) studied the effect of fly ash exposure on Bufo terrestris at U.S. They were observed the embryonic and larval stage of Bufo terrestris and studied the effect of fly ash exposure on the survival and performance of larva. They reported that the survival rate of embryo in fly ash polluted water were low in comparison to non-fly-ash polluted water. Survived individuals in coal ash contaminated water were showed better resistance against the other stress present in natural non polluted site. Oral and spinal deformities were not appearing in any animal, regardless to their hatching site. Complete recruitment of Bufo terrestris in coal ash contaminated site not successful thus C. L. Rowe et al concluded that coal ash contaminated area may serve as breeding sink for toads from the local population. Hung Nguyen-Viet (2004) studied the effect of atmospheric pollutant on the density and diversity of protozoa and reported relation between NO^2 concentration and the testate amoeba presence in polluted environment. John H. Roe et al (2004) studied the reptilian eggs (Alligator mississippiensis) at drainage swamp which receives effluent from power plant and downstream from power plant and a tributary river contaminated with drange and nearby natural pond. They reported clutch, eggs and hatching were larger in BDC site in comparison to ABS & REF site, but the viability of clutches was higher at REF site. Analysis of element concentration showed higher Selenium concentration in eggs collected from ABS drainage swamp as compare to other 2 study sites at South Carolina, USA. They were reported higher concentration of As, Cd, Cr, Cu, and Se at studying fly ash disposal site, but they reported Se as the highly maternally transferred element in all above elements (Table 4).

Table 3 Fly ash generation and utilization in different countries

S.No.	Country	Annual Ash Production (MT)	AshUtilization (in %)
1	India	112	38
2	China	100	45
3	USA	75	65
4	Germany	40	85
5	UK	15	50
6	Australia	10	85
7	Canada	6	75
8	France	3	85
9	Denmark	2	100
10	Italy	2	100
11	Netherland	2	100

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Table 4 Concentration of elements in Fly Ash (in mg/kg)

S.No.	elements	FA-S1	FA-S2	FA-S3	BA-S1	BA-S2	BA-3
1	Cr	103	90	87	74	72	54
2	Mn	62	47	139	182	118	84
3	Pb	56	20	34	16	16	10
4	Zn	124	60	64	43	44	29
5	Cu	83	56	58	50	46	40
6	Ni	63	39	28	31	32	26
7	Co	18	13	8	11	10	9

BA-S1- Bottom ash sample from thermal power station 1
(Coal supplied from Jharia coal fields)
BA-S2- Bottom ash sample from thermal power station 2
(Coal supplied from North Piparwar Mines)
BA-S3- Bottom ash sample from thermal power station 3
(Coal supplied from Gevra Mine)

Table 5 Comparison in-betweens concentration of elements in Fly Ash (sample collected from three thermal power station fed coal of Jharia coal fields, North Piparwar Mines, Gevra Mines at India and compared with collected literature value from other countries)

S.No.	Elements	S-1	S-2	S-3	Greece	Spain	UK	China	Average value (India)
1	Cr	103	90	87	110-160	134.2	n/r	n/r	120
2	Co	18	13	8	n/r	29.2	n/r	n/r	23.6
3	Cu	83	56	58	31.8-62.8	71.8	n/r	n/r	100
4	Pb	56	20	34	123-143	52	17-176	843-847	35
5	Mn	62	47	139	213-330	324.6	n/r	n/r	338.91
6	Ni	63	39	28	n/r	87.9	n/r	n/r	150
7	Zn	124	60	64	59.6	221.3	n/r	n/r	n/r

S1-sample from thermal power station 1(coal supplied from Jharia coal fields)
S2- sample from thermal power station 2(coal supplied from North Piparwar Mines)
S3- sample from thermal power station 3(coal supplied from Gevra Mine)
Nr-not representative

Table 6 Fauna at fly ash dyke

S.No.	Ash site	Fauna at dyke 1	Fauna at dyke 2
1	Hot slurry	None	None
2	Fresh pond	None	None
3	Old pond	Euglena, Paramecieum, frogs, Carnes, grasshopper, Beetles, Mosquitoes	Euglena, cyst
4	Drying pond	All the above animals	Euglena, Paramecieum, Mosquitoes
5	Moist ash	Flies, mosquitoes	Mosquitoes
6	Dry ash	Cyst only	none

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Joel W. Snodgrass et al. (2004) studied the effect of exposure of coal combustion waste on larva of some amphibians (Anuran species) and reported high mortality rate among developing larva in coal combustion waste contaminated site in US. Joel W. Snodgrass et al. (2005) studied the effect of coal combustion waste on the larval period of an amphibian, Rana clamitans at U.S.A. John H. Roe et al. (2006) studied effect of the coal combustion waste on reptilian larvae and metamorphs (Salamander) which were laid in fly ash contamined temporary pond at U.S.A. Douglas J. Fort et al. (2006) with his coworkers studied the Nickel toxicity in three amphibian species I-Gstrophryne carolinensis, II-Bufo terrestris and III- Xenopus laevis in USA (Table 5). Danika M.Kuzmick et al. (2007) studied the effect of coal combustion residual exposure on life cycle of Grass shrimp in contaminated site at USA. Jason M. Unrine (2007) studied the impact of trace elements presented in power plant effluents and its effect on amphibian and bioaccumulation in other organism through food web at USA. They were collected samples from a drainage swamp which was contaminated by the coal combustion waste from thermal power plant situated near Aiken SC, USA. For the study were grouped all organism according their size and tested the trace element level in their body tissue. The size of Bullfrogs larvae indicated that they were most likely <1-year old and they had not yet developed hind limbs. Jason M. Unrine reported relatively higher bioaccumulation of trace elements (V, Mn, Fe, Zn, As, Se, Pb) in Bullfrog larvae in comparison to other organisms. But as an exception in this study the Heliosoma trivolvis had highest concentration of Mn and Bullfrog larvae were on second position in Mn concentration (Table 6). They stated that the bioaccumulation of trace elements relatively higher in lower trophic level. The larvae of Rana catesbeiana and some other small vertebrates with 4 species of invertebrates at site were contaminated by the trace elements. Gretchen Loeffler Peltier et al. (2008) studied the effect of contamination of trace elements from different sources included power plant and pollution load on river water, using Corbicula fluminea as bioindicator (inhabitating organism). In 2009 he also reported accumulation of trace element in Corbicula fluminea occur at downstream. C.R. Shalinimol (2009) studied protozoan population in soil and reported protozoan abundance in relation to soil aggregates. J. Selvin Pitchaikani et al. (2010) studied the effect of disposed heated effluent and ash slurry on the physio-chemical properties of sea water, they recorded low DO, high transparency study point 1, which is nearer to thermal power plant in comparison to other two study point which are far from the power plant. But pH was not fluctuated in significant amount. The high nutrient concentration was recorded in study point 1, near the thermal power plant. They conclude their study as DO, transparency increased with the distance from effluent discharging point and nutrition concentration were decreased with distance from thermal power plant. Christopher J. Salice, Christopher L. Rowe et al. (2011) studied the effect of fly ash contamination on the breeding place aviability of amphibians and reported as sink for breeding process. Bryan (2012) reported that bird showed positive behavior to nesting in fly ash basin but it may be harm full for their eggs due to the presence of metalloids. At same year Brian et al reported low survival rate of the amphibian larvae to the fly ash exposure.

4. CONCLUSION

In this paper we have analyzed in total 65 papers .Out of which 59 were research papers, and 6 were reports and Ph.D. theises. We found that Mr. N.L. Rose with his coworkers have worked a lot on fly ash and the effect of fly ash contamination on soil structure of water body. Liao H.C., Jiang S.J and P. K. Rohatgi, P Huang, R Guo, B N Keshavaram, D. Gold and Praharaj T., Powell M.A., Hart B.R., Tripathi S. studied the morphology of fly ash particles and the leacheability of some elements. We also found that India is one of the largest producer of fly ash in international contex. Approximately 100 million ton/ year fly ash produced during power generation in India and this data will reach above 175 Mt till 2012 due to our continuous progress in the power field. In India near about 70% power generated by the thermal power plant. Out of them about 84% thermal power plants are used coals for electricity production which is responsible for production of approximates 110 MT fly ash per year. But only 38% of fly ash utilized of total production in different sectors as in cement factories, low laying area fill, roads and embankment, dyke raising, brick manufacturing, in agriculture. As we know from previous studies some essential nutritive elements also present in fly ash in trace amount which are important to growth of plant thus fly ash used to improve soil structure by farmers in different combinations with fertilizers. Fly ash was used in our surroundings and parallel it entered the ecosystem through air, water and soil and affects living organism in different trophic levels. From the previous studies we can say that animal life get affected in many ways by fly ash contamination as other chemicals but enormous production and continuous use of fly ash in our surrounding may create problems for animal diversity thus we have to alert before the alarming. After the study of previous research work we have not found any study related to fauna or animals which are occurred and survived in fly ash slurry and in fly ash discharge water pond except Dr. S. Shrivastava, she was reported some animals in ash pond and in reclaimed ash dyke during 2006-07. Thus the study of animals in relation to fly ash becomes essential to know its better way utilization without any adverse effect to our environment.

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SUMMARY OF RESEARCH

Summing up all the previous studies we can say that the study of fly ash is not new and the work on fly-ash was done from as early as 200 BC by ancient cultures of which we know as volcanic ash. Volcanic ash and fly ash differ only in their formative process, volcanic ash forms after natural combustion in earth's depth while fly ash is produced during combustion by humans at thermal power station. The term fly ash was first of all used in a proceeding of American Concrete Institute in 1937 while according to records fly ash used firstly in 1930 in asphalt as mixing material.

1. Easy aviability and low cost with good physical properties (like low specific gravity, freely draining & frictional property) of fly ash made it to be used in construction business. To use it in proper way scientist and many associations were interested for developing it as eco-friendly wealth product rather than pollutant & hazardous material.
2. Study of coal ash and its inter-relation to living organisms or fauna started from 1979 when Donald S. Cherry and coworkers reported the impact of coal ash effluents on the density of aquatic invertebrates of effluent receiving drainage system. Many scientists were reported the receiving water body and alternation in the population of inhabitating organisms which were belonging from different trophic level and texas.
3. Leaching and bioaccumulation of fly ash constituent were also reported in some studies as we previously discussed.
4. Some elements present in fly ash helps to maintain soil quality, so fly ash used frequently for different purposes as vermiculture and agriculture. It is used as a mix with fertilizers. Some reclaimed ash dumping area provide shelter for local fauna and ash mixed soil bed promote the growth of organism as reported in vermiculture.

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Data and materials availability: All data associated with this study are present in the paper.

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